MECE 574 Industrial Automation and Robotics Technology

Fall 2025

Department of Mechatronics Engineering
Atilim University

Assignment submission deadline: 09:30hrs, 30 Oct 2025

First six problems are paper based, which you will submit by hand. The last two problems are computer-based, which you will perform through MATLAB and RoboDK. You will upload the zip of your project on MOODLE in the given time and name it as

Öğrenci Numara_Adı_Soyadı.zip

Q 1: Consider the robotic tool shown in Figure 1 below. Sketch the tool position after each intermediate position of the following YPR operation: yaw $\pi/2$, pitch $-\pi/2$, roll $\pi/2$.

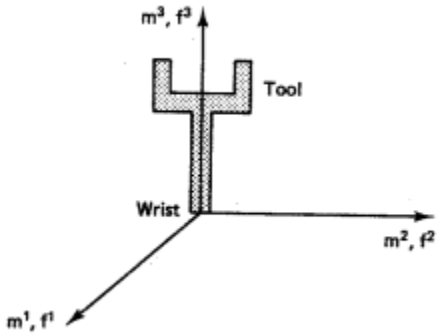


Figure 1: Tool in 3D reference frame

Q 2: Consider the following coordinate transformation matrix, which represents a fundamental rotation. What is the axis of rotation (x, y, or z), and what is the angle of rotation?

$$R = \begin{bmatrix} 0.5 & 0 & -0.866 \\ 0 & 1 & 0 \\ 0.866 & 0 & 0.5 \end{bmatrix}$$

Q 3: A point P in space is defined as ${}^{B}P = (2,3,5)^{T}$ relative to frame B which is attached to the origin of the reference frame A and is parallel to it. Apply the following transformations to frame B and find ${}^{A}P$.

Rotate 90 deg about x-axis, then

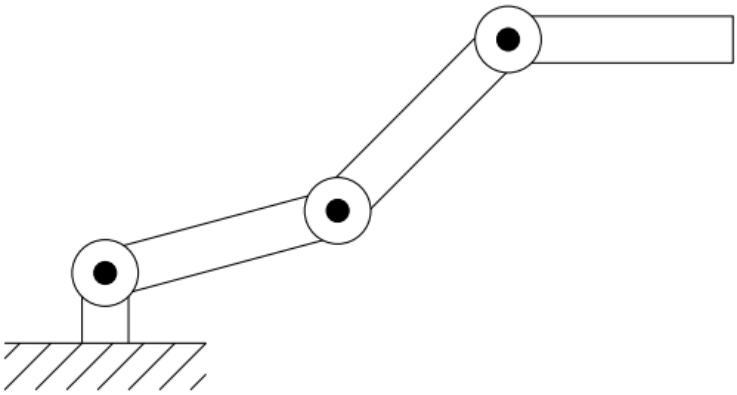
Rotate 90 deg about local a-axis, then

Translate 3 units about γ, 6 units about z and 5 units about x-axis.

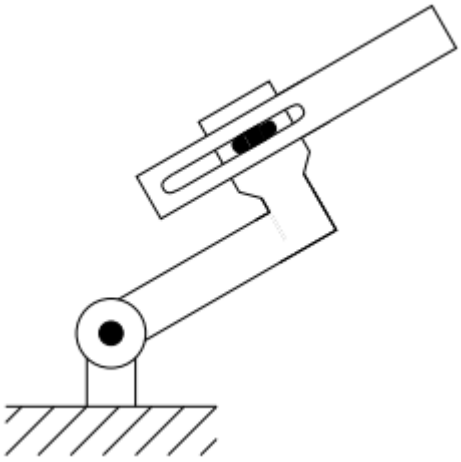
Q 4: Suppose that a robot is made of a Cartesian and Euler combination of joints. Find the necessary Euler angles to achieve the following:

$$T = \begin{bmatrix} 0.527 & -0.574 & 0.628 & 4 \\ 0.369 & 0.819 & 0.439 & 6 \\ -0.766 & 0 & 0.643 & 9 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Q 5: For a three-link planar manipulator shown in Figure below, derive the forward kinematic equations using the DH convention and clearly draw coordinate frame assignment diagram.



Q 6: Consider the two-link manipulator which has joint 1 revolute and joint 2 prismatic. Derive the forward kinematics equations using DH-convention and clearly draw coordinate frame assignment diagram.



Q 7: Pick any two manipulators of your choice, 3 dof or above. You can borrow the kinematic model from any source, but don't forget to cite it. In MATLAB, write a program to perform following operations.

a. Program transformation matrices based on DH parameters.
b. Ask the user to pick a robot of his/her choice and then input angles. As an output, individual homogeneous transformation matrices must be displayed along with the composite homogeneous transformation matrix from base to tool.
c. Plot the manipulator (preferably in 3D space) and attach the reference axis according to the DH parameters.

It would be better if you pick any manipulator that also exists in the RoboDK library to counter check the results.

Q 8: In RoboDK, using a Univeral robot or Fanuc robot, perform these tasks.

1. Add a small box as an object of interest.
2. Create 4 target points, home, pick, place, and retract.
3. Introduce any end-effector to perform pick and place operations. Use 'Attach Object' and 'Detach Object' instructions (events) to observe the move.
4. Run it as a program.

The operation is a simple pick and place operation.